KABBALDURGA-TYPE CHARNOCKITIZATION: A LOCAL PHENOMENON IN THE GRANULITE TO AMPHIBOLITE GRADE TRANSITION ZONE

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In the deeply eroded Precambrian crust of South India and Sri Lanka, a series of spectacular exposures shows progressive development of coarse-grained charnockite through dehydration of amphibolite grade gneisses in different arrested stages (1,2,3, 4,5,6).

At Kabbaldurga, charnockitization of Archaean grey biotite-hornblende gneisses (3.4 Ga; U-Pb zircon upper intercept data (7)) occurred about 2.5 Ga ago (U-Pb zircon lower intercept data and Rb-Sr whole rock isochron (7)) and evidently was induced by the influx of external carbonic fluids along a system of ductile shears and the foliation planes (3,4,6). The results of oxygen isotope thermometry (6) and of geothermobarometry in adjacent areas (8,9) indicate a P-T regime of 700-750 ^{o}C and 5-7 kb. The decrease of water activity in the fluid infiltrated zones caused an almost complete breakdown of hornblende and biotite and the new growth of hypersthene. Detailed petrographic and geochemical studies (6) revealed marked changes in mineralogy and chemistry from granodioritic to granitic which document the metasomatic nature of the process.

The marked gain in K, Rb, Ba and Si is attributed to intense replacement of plagioclase by K-feldspar through cation exchange with the passing fluids, whereas the loss of Fe, Mg, (Ca), Ti, Zn, V, P and Zr resulted from dissolution of hornblende, biotite, magnetite, apatite and zircon (6). A systematic depletion of the REE and especially the HREE in the charnockites which is attributable mainly to the progressive dissolution of zircon, led to strongly fractionated REE patterns with positive Eu-anomaly (La_N/Yb_N 20-80; Eu_N/Eu_N^* up to 1.8).

In the case of Kabbaldurga, an external source for the carbonic fluids is indicated by the fluid inclusion characteristics and stable isotope data (3,4,6). While most workers assume a generation of these fluids by deep-seated processes, e.g. degassing of underplated basaltic magmas, decarbonation of subducted sediments or the upper mantle (2,3,4), it is suggested here that the most likely source for the carbonic fluids is the 'fossil' reservoir of carbonic fluids trapped in the deeper crustal granulites underlying the gneiss terrane at Kabbaldurga. Shear deformation has tapped this reservoir and generated the pathways for fluid ascent.

The regional distribution of exposures with 'in-situ' charnockitization in southern India and Sri Lanka clearly indicates that this process was restricted to a zone transitional to the deeper and pervasingly granulitized crust. The evidences from Kabbaldurga and similar exposures in southern Kerala (5, 10) and Sri Lanka (4, 11) show that dehydration and the intensity of accompanying metasomatism were controlled by fluid-rock inter-

action in a system of tectonically generated fluid-pathways. Despite the differences in the mineralogy and chemistry of the precursor gneisses, the final product is always a coarse-grained massive hypersthene-bearing rock of granitic composition (charnockite s.str.). In all cases, 'in-situ' charnockitization was a late process which occurred well after the major event of penetrative deformation, high-grade metamorphism and migmatisation when during uplift the rheological properties of the rocks changed from ductile to brittle. Thus it appears unlikely that this type of charnockite formation caused the pervasive granulitisation of extensive parts of Precambrian lower crust in southern India and Sri Lanka.

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